

Department of Defense Birth and Infant Health Registry: Select Reproductive Health Outcomes, 2003–2014

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Established following a 1998 directive, the Department of Defense Birth and Infant Health Registry (Registry) team conducts surveillance of select reproductive health outcomes among military families. Data are compiled from the Military Health System Data Repository and Defense Manpower Data Center to define the Registry cohort and outcomes of interest. Outcomes are defined using ICD-9/ICD-10 and Current Procedural Terminology codes, and include: pregnancy outcomes (e.g., live births, losses), birth defects, preterm births, and male:female infant sex ratio. This report includes data from 2003–2014 on 1,304,406 infants among military families and 258,332 pregnancies among active duty women. Rates of common adverse infant and pregnancy outcomes were comparable to or lower than those in the general U.S. population. These observations, along with prior Registry analyses, provide reassurance that military service is not independently associated with increased risks for select adverse reproductive health outcomes. The Registry's diverse research portfolio demonstrates its unique capabilities to answer a wide range of questions related to reproductive health. These data provide the military community with information to identify successes and areas for improvement in prevention and care.

The Department of Defense Birth and Infant Health Registry (Registry) was established following a 1998 directive from the Assistant Secretary of Defense for Health Affairs.¹ Prior to the establishment of the Registry, the absence of baseline data hindered the ability to evaluate effects of military-unique exposures of potential concern on reproductive health outcomes. The Registry is an important resource for monitoring the reproductive health of military families and findings are frequently shared through scientific conferences, peer-reviewed journals, special reports, and annual reporting of the prevalence of birth defects through a partnership with the National Birth Defects Prevention Network (NBDPN). Registry data are collected, maintained, and analyzed by the

Deployment Health Research Department at the Naval Health Research Center in San Diego, CA.

Outcomes among active duty mothers are a subset of the Registry's data, which document maternal, pregnancy, and infant outcomes among all military families (i.e., TRICARE beneficiaries). Hence, the Registry's data comprise a large study population for assessing parental exposures, outcomes among dependent spouses, and differences between military and civilian populations. This report describes characteristics and outcomes among infants born to active duty women in calendar years 2003–2014, with additional data presented on pregnancies among active duty women and on outcomes for the Registry population as a whole, for this same time frame.

METHODS

Population and data sources

The Registry comprises data pertaining to a population-based, retrospective cohort of infants and pregnancies among U.S. military families and currently includes data on nearly 1.8 million infants born during 1998–2014. The military parent acts as the sponsor, or primary beneficiary of TRICARE coverage, and family members are dependent beneficiaries through the sponsor. Maternal/sponsor and infant data are compiled from the Military Health System Data Repository (MDR) and Defense Manpower Data Center (DMDC). The MDR houses administrative medical claims data for both inpatient and outpatient encounters at military and civilian treatment facilities. Medical encounters are coded with International Classification of Diseases, Ninth/Tenth Revision, Clinical Modification/Procedure Coding System (ICD-9/ICD-10) diagnostic and procedure codes, as well as Current Procedural Terminology (CPT) codes. For this report, ICD-10 codes were used only for defining birth defects among infants born during the last 3 months of 2014, because their first years of life overlapped the first 3 months after ICD-10 coding went into effect (1 October 2015). Medical encounter data, along with TRICARE enrollment and eligibility data maintained by DMDC, are used to define the Registry infant cohort (including their mothers and military sponsors) and to ascertain outcomes through the first year of the infants' lives. Same-sex multiple infants are excluded from the Registry due to difficulties in differentiating their medical records. Estimated gestational age (EGA) is derived from ICD codes, and the estimated date of last menstrual period (LMP)

is calculated by subtracting EGA from the delivery date.

The Registry data have a lag of approximately 2 years: 1 year for all infants in a cohort year to reach 1 year of age, and 1 year for the medical encounter data to be fully populated. Although the Registry includes data on infants born as far back as 1998, for most studies/reports the data are limited to those infants born in 2003 or later. This limitation is due to changes in ICD-9 coding for gestational age, which were implemented at that time and allow for more granularity in the assignment of gestational age and improve accuracy when assessing the timing of exposures relative to pregnancy.

The Registry also includes data on pregnancies, including those that do not result in live deliveries, for women who were active duty service members through the duration of their pregnancies. To estimate the LMP of pregnancies not ending in live deliveries, the median number of days from LMP to start of pregnancy care for live deliveries is subtracted from the earliest date of pregnancy care. EGA is determined by calculating the difference between estimated LMP and pregnancy end date (for pregnancies ending in loss) or last date of pregnancy care (for pregnancies with unknown outcomes). For all pregnancies, the expected date of delivery (EDD) is calculated by adding 40 weeks to LMP.

Outcomes

The Registry routinely captures data on the male:female infant sex ratio, an indicator of overall population reproductive health,² as well as on adverse infant outcomes, including major birth defects, preterm birth, and low birth weight (LBW). Birth defects are defined using the current case definitions from the NBDPN,³ which are based on ICD-9 and ICD-10 codes in the ranges of 740.x–760.x and Q00–Q99, respectively. At least one inpatient diagnosis or two outpatient diagnoses on different days are required for a birth defect to be included as a case. Preterm birth, or birth before 37 completed weeks of gestation, is based on an infant's EGA at birth, defined by ICD-9 codes from records of the infant or mother: weeks of gestation 756.2;

preterm birth 765.x; postterm newborn 766.2x; multiple birth V3[1–5].xx; preterm delivery 644.2x; postterm pregnancy 645.[1,2]x; or multiple gestation or delivery 651.xx, V27.[2,3,5,6]x.

LBW (i.e., birth weight under 2,500 grams) is determined from ICD-9 codes 764.xx, 765.0x, and 765.1x; the fifth digit indicates a birth weight category. The first code recorded within 28 days of an infant's birth is used to establish the weight category. If more than one code is assigned on the same day, the lowest recorded weight is used. Infants with no weight codes in their records are assumed to be of normal birth weight.

Pregnancies and their outcomes are defined using pregnancy-related ICD-9 diagnostic codes in the range of 630.x–679.x, as well as ICD-9 and CPT procedure codes. Pregnancy outcomes described in this report include live deliveries, stillbirths, all other pregnancy losses, and unknown outcomes. Live deliveries are defined by a maternal live delivery ICD-9 code (V27.[0,2,3,5,6]) on an inpatient encounter record that links to a live born infant. In the absence of a live delivery, a pregnancy is classified as having ended in a loss if there is an ICD-9 code indicating pregnancy loss (ectopic and molar pregnancy 630.xx–633.xx; other pregnancy with abortive outcome 634.xx–639.xx; intrauterine fetal death/stillbirth 656.4x; V27.[1,3,4,6,7]) or an ICD-9 or CPT code indicating treatment of a pregnancy loss, and there are no encounters in the subsequent 60 days indicating an ongoing pregnancy. Among pregnancies classified as losses, stillbirths are defined as those with an ICD-9 stillbirth code (intrauterine fetal death 656.4x; outcome of delivery V27.[1,3,6,7]) on an inpatient encounter record at the end of the pregnancy. Pregnancies that cannot be defined as live deliveries or losses, due to loss to follow-up or conflicting pregnancy data, are classified as having unknown outcomes. Pregnancies with any indication of an elective abortion are excluded from reporting (ICD-9 diagnostic codes: legally induced abortion 635.xx; illegally induced abortion 636.xx; ICD-9 procedure codes: intra-amniotic injection for abortion 75.0; hysterotomy to terminate pregnancy 74.91; dilation and curettage for

termination of pregnancy 69.01; aspiration curettage of uterus for termination of pregnancy 69.51; CPT codes: induced abortion by dilation and curettage 59840; induced abortion by dilation and evacuation 59841; induced abortion by one or more intra-amniotic injections 59850–59852; or, induced abortion by 1 or more vaginal suppositories 59855–59857).

Covariates

Outcomes are described according to a variety of maternal/sponsor and infant covariates. Maternal demographic data, other than age, are available only when the mother is the military sponsor. Maternal age at infant's date of birth (or at EDD for pregnancies) is reported in both categorical and continuous form. Additional maternal/sponsor covariates include marital status (married, not married), race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, Asian/Pacific Islander, American Indian/Alaska Native, other/unknown), educational attainment (less than a bachelor's degree, bachelor's degree or greater), branch of service, military pay grade (E1–E3, E4–E6, E7–E9, O1–O3, O4–O9, W1–W5, unknown), military rank (enlisted, officer, warrant officer, unknown), and military occupation (combat specialist, health-care specialist, other/unknown). Infant covariates include year of birth, birth facility type (military, civilian, unknown), and plurality (singleton, multiple).

RESULTS

Population characteristics

Registry records reviewed for this report covered 1,304,406 infants born in 2003–2014, including 174,921 (13%) born to active duty women and 1,043,812 (80%) born to dependent spouses of active duty service members (**Table 1**). Infants born to Reserve/National Guard mothers and other beneficiary types (e.g., retirees) make up the remaining 7%. Active duty mothers were slightly younger than dependent spouse mothers. Compared with the military sponsors of dependent spouses, active duty mothers were more likely to be non-white,

TABLE 1. Characteristics of infants, by maternal beneficiary type, Department of Defense Birth and Infant Health Registry, 2003–2014

Characteristics	Maternal beneficiary type					
	Active duty (N=174,921)		Dependent spouse (N=1,043,812)		Registry overall (N=1,304,406)	
	No.	%	No.	%	No.	%
Maternal age at infant birth (years)						
<20	5,315	3.0	45,353	4.3	61,094	4.7
20–24	76,617	43.8	334,909	32.1	424,516	32.5
25–29	52,349	29.9	347,851	33.3	408,765	31.3
30–34	27,408	15.7	213,556	20.5	246,909	18.9
35–39	11,190	6.4	84,670	8.1	98,797	7.6
≥40	2,042	1.2	17,473	1.7	20,625	1.6
Unknown	0	-	0	-	43,700	3.4
Mean (SD)	26.0	(5.1)	27.0	(5.3)	26.8	(5.3)
Median (IQR)	25	(22–29)	26	(23–31)	26	(23–30)
Sponsor marital status						
Married	127,092	72.7	974,711	93.4	1,159,375	88.9
Not married	47,829	27.3	69,101	6.6 ^a	145,031	11.1
Sponsor race/ethnicity						
Non-Hispanic white	83,645	47.8	727,580	69.7	861,810	66.1
Non-Hispanic black	48,519	27.7	122,057	11.7	189,242	14.5
Hispanic	23,855	13.6	113,073	10.8	145,292	11.1
Asian/Pacific Islander	10,903	6.2	47,952	4.6	62,530	4.8
American Indian/Alaska Native	4,076	2.3	17,577	1.7	22,923	1.8
Other/unknown	3,923	2.2	15,573	1.5	22,609	1.7
Sponsor educational attainment						
Less than bachelor's degree	144,755	82.8	791,754	75.9	993,791	76.2
Bachelor's degree or greater	30,166	17.3	252,058	24.2	310,615	23.8
Sponsor branch of service						
Army	60,789	34.8	464,064	44.5	568,571	43.6
Air Force	53,816	30.8	228,178	21.9	300,596	23.0
Navy	46,802	26.8	211,230	20.2	274,577	21.1
Marine Corps	13,514	7.7	140,340	13.4	160,662	12.3
Sponsor pay grade						
E1–E3	38,806	22.2	143,281	13.7	193,721	14.9
E4–E6	107,728	61.6	638,165	61.1	796,103	61.0
E7–E9	4,644	2.7	71,184	6.8	89,262	6.8
O1–O3	16,839	9.6	122,611	11.8	145,039	11.1
O4–O9	6,311	3.6	56,025	5.4	66,049	5.1
W1–W5	592	0.3	12,521	1.2	14,164	1.1
Unknown	1	<0.1	25	<0.1	68	<0.1
Sponsor rank						
Enlisted	151,179	86.4	852,635	81.7	1,079,093	82.7
Officer	23,150	13.2	178,638	17.1	211,090	16.2
Warrant officer	592	0.3	12,521	1.2	14,164	1.1
Unknown	0	0.0	18	<0.1	59	<0.1
Sponsor occupation						
Combat specialist	11,103	6.4	257,773	24.7	279,601	21.4
Healthcare specialist	33,749	19.3	63,932	6.1	104,263	8.0
Other/unknown	130,069	74.4	722,107	69.2	920,542	70.6
Infant birth facility type						
Military	123,267	70.5	434,642	41.6	575,472	44.1
Civilian	51,636	29.5	608,522	58.3	719,326	55.1
Unknown	18	<0.1	648	0.1	9,608	0.7
Infant plurality						
Singleton	172,710	98.7	1,030,603	98.7	1,287,856	98.7
Multiple	2,211	1.3	13,209	1.3	16,550	1.3

SD, standard deviation; IQR, interquartile range

^aDiscrepancy between beneficiary status and marital status due to variations in lag times for status change updates

have less than a college education, and be in a healthcare or other/unknown occupation. Registry live births occurred in all 50 states and the District of Columbia, as well as overseas, with the highest numbers in locations with a greater U.S. military presence (birth location was unknown for 9,608 infants). On average, 100,088 Registry live births occurred annually in the U.S. with the highest numbers of live births in California (11,524), Texas (9,975), Virginia (8,547), and North Carolina (7,972). Internationally, Germany (2,988) and Japan (2,164) had the highest average numbers of Registry live births per year.

Infants born to active duty women

The annual numbers of infants born to active duty women ranged from 13,602 to 15,414 during 2003–2014, with the highest counts among Army women (Figure 1). Women aged 20–24 years had the highest annual numbers of births, although these numbers decreased over time, as did births among women less than 20 years of age (Figure 2). Conversely, births increased among women aged 30 years or older.

The male:female infant sex ratio was consistently greater than 1.0 across all demographic/military groups. Rates of birth defects increased with advancing maternal age, male infant sex, and plurality (Table 2). The overall rate of major birth defects gradually increased between 2003 and 2014, with male infants having higher rates than females (Figure 3). Cardiovascular defects were the most common, followed by genitourinary and musculoskeletal defects (Figure 4). This pattern was apparent among the ten most prevalent individual birth defects diagnosed among infants of active duty mothers (Table 3).

Preterm birth rates were highest among infants born to the youngest (less than 20 years) and oldest (35 years or older) mothers. Rates were also highest among infants born to unmarried mothers and to non-Hispanic black mothers. Similar increases in rates were seen for LBW (Table 2). Annual rates of preterm birth declined between 2003 and 2014 and were higher among male infants. Rates of LBW were relatively stable and higher among female infants (Figure 5).

FIGURE 1. Number of annual live births to active duty U.S. military women, by branch of service, Department of Defense Birth and Infant Health Registry, 2003–2014

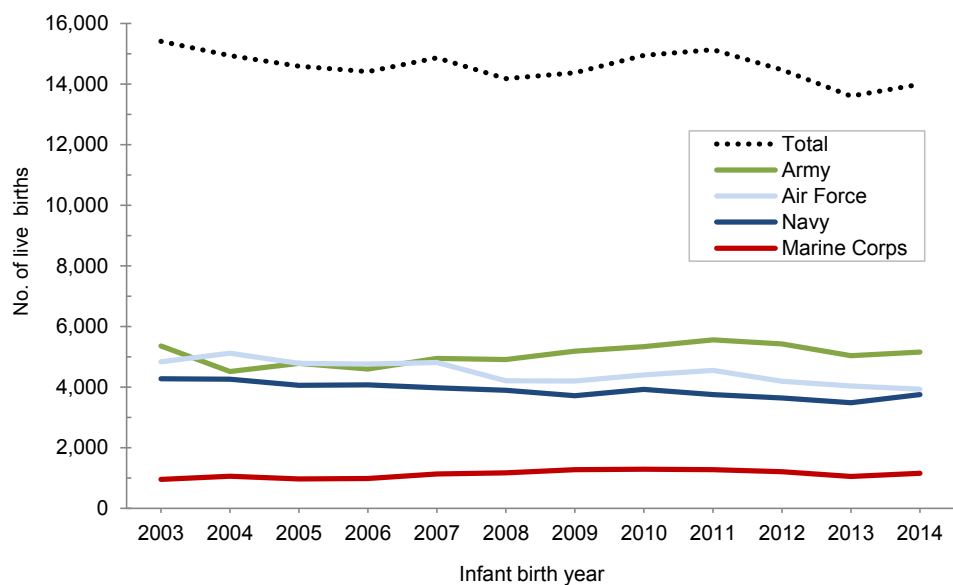
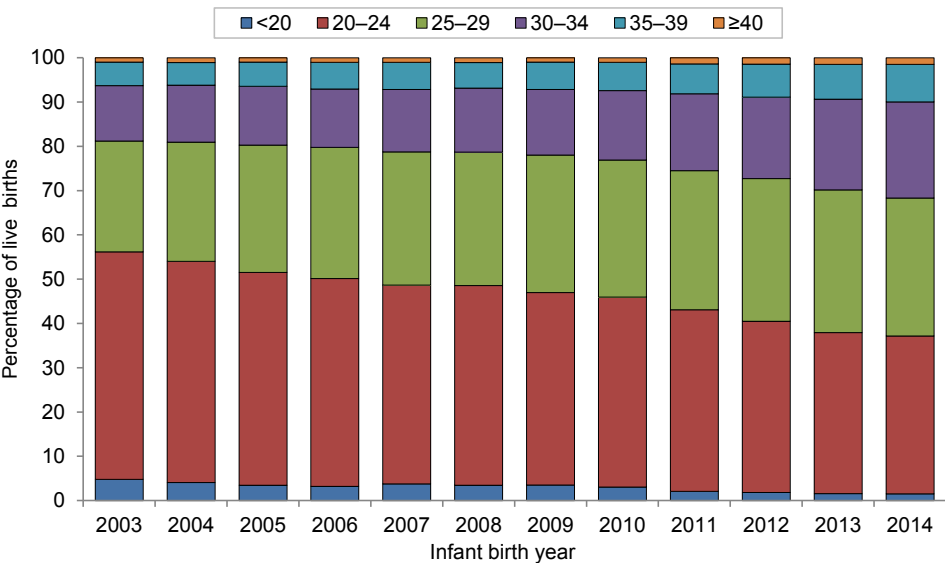


FIGURE 2. Annual distribution of live births, by maternal age at delivery, among infants born to active duty U.S. military women, Department of Defense Birth and Infant Health Registry, 2003–2014



Infants born to dependent spouses and those in the overall Registry

The number of infants born to dependent spouses ranged from 73,665 in 2003 to a high of 97,110 in 2011 (Figure 6). In 2003, nearly 50% of dependent spouses’ infants were born in military hospitals. Since then,

that proportion has declined to approximately 40% (Figure 7), although the total number of annual births has remained relatively constant (Figure 6). Among infants born to active duty women, approximately 70% were born at military treatment facilities and this proportion has remained stable over time (Figure 7). Trends for all Registry

TABLE 2. Infant outcomes, by maternal and infant characteristics, among infants born to active duty U.S. military women, Department of Defense Birth and Infant Health Registry, 2003–2014

Characteristics	Infant sex			Any birth defect		Preterm birth		Low birth weight	
	Male (M)	Female (F)	M:F ratio	No.	Rate ^a	No.	Rate ^a	No.	Rate ^a
	No.	No.							
Overall	89,422	85,499	1.05	5,407	3.1	15,714	9.0	9,056	5.2
Maternal age at infant birth									
<20	2,687	2,628	1.02	155	2.9	569	10.7	404	7.6
20–24	39,031	37,586	1.04	2,235	2.9	6,516	8.5	3,862	5.0
25–29	26,952	25,397	1.06	1,624	3.1	4,405	8.4	2,472	4.7
30–34	14,012	13,396	1.05	871	3.2	2,622	9.6	1,426	5.2
35–39	5,683	5,507	1.03	436	3.9	1,300	11.6	706	6.3
≥40	1,057	985	1.07	86	4.2	302	14.8	186	9.1
Maternal marital status									
Married	64,991	62,101	1.05	3,909	3.1	10,989	8.6	6,059	4.8
Not married	24,431	23,398	1.04	1,498	3.1	4,725	9.9	2,997	6.3
Maternal race/ethnicity									
Non-Hispanic white	42,931	40,714	1.05	2,724	3.3	6,560	7.8	3,295	3.9
Non-Hispanic black	24,604	23,915	1.03	1,511	3.1	5,597	11.5	3,712	7.7
Hispanic	12,170	11,685	1.04	692	2.9	1,933	8.1	1,146	4.8
Asian/Pacific Islander	5,589	5,314	1.05	273	2.5	969	8.9	530	4.9
American Indian/Alaska Native	2,112	1,964	1.08	108	2.6	325	8.0	165	4.0
Other/unknown	2,016	1,907	1.06	99	2.5	330	8.4	208	5.3
Maternal education									
Less than bachelor's degree	73,992	70,763	1.05	4,428	3.1	12,917	8.9	7,560	5.2
Bachelor's degree or greater	15,430	14,736	1.05	979	3.2	2,797	9.3	1,496	5.0
Maternal branch of service									
Army	31,019	29,770	1.04	1,877	3.1	5,910	9.7	3,545	5.8
Air Force	27,661	26,155	1.06	1,703	3.2	4,453	8.3	2,420	4.5
Navy	23,955	22,847	1.05	1,430	3.1	4,314	9.2	2,487	5.3
Marine Corps	6,787	6,727	1.01	397	2.9	1,037	7.7	604	4.5
Maternal rank									
Enlisted	77,272	73,907	1.05	4,623	3.1	13,569	9.0	7,900	5.2
Officer	12,150	11,592	1.05	784	3.3	2,145	9.0	1,156	4.9
Maternal occupation									
Combat specialist	5,634	5,469	1.03	346	3.1	970	8.7	573	5.2
Healthcare specialist	17,380	16,369	1.06	1,056	3.1	3,083	9.1	1,737	5.1
Other/unknown	66,408	63,661	1.04	4,005	3.1	11,661	9.0	6,746	5.2
Infant plurality									
Singleton	88,326	84,384	1.05	5,300	3.1	13,687	7.9	7,970	4.6
Multiple	1,096	1,115	-	107	4.8	2,027	91.7	1,086	49.1
Infant sex									
Male	-	-	-	3,112	3.5	8,309	9.3	4,336	4.8
Female	-	-	-	2,295	2.7	7,405	8.7	4,720	5.5

^aRates per 100 live births

infants mirror those for infants born to dependent spouses, as the latter comprise the majority of the Registry population.

Table 4 shows male:female infant sex ratios and rates of other outcomes for infants born to dependent spouses and for the Registry overall, by maternal/sponsor and infant characteristics. Similar to infants born to active duty women, the

male:female infant sex ratio among infants born to dependent spouses was consistently greater than 1.0 across all groups. Birth defect rates were higher with increasing maternal age, male infant sex, and plurality. Rates of preterm birth and LBW were highest among the youngest (less than 20 years) and oldest (35 years or older) mothers, as well as among infants born to women with

unmarried sponsors and non-Hispanic black sponsors. The preterm birth rate was higher among male infants, while the LBW rate was higher among female infants.

The 10 most prevalent birth defects diagnosed in the infants of all Registry mothers are listed in **Table 3**. This ranking is largely the same as that for infants born to active duty women. Similarly, the most

prevalent birth defects included those that affect the cardiovascular, genitourinary, and musculoskeletal systems.

Pregnancies among active duty women

Approximately 20,000–25,000 pregnancies were identified among active duty women each year between 2003 and 2014. Of these, nearly 70% resulted in a live delivery, 0.3% in a stillbirth, and 16% in another type of pregnancy loss (e.g., spontaneous abortion; Table 5). For 14% of pregnancies, an outcome could not be determined. Stillbirth rates were highest among non-Hispanic black women, while rates of other losses were higher among older (≥ 35 years) and unmarried women (data not shown). Additional details on pregnancy characteristics are provided in Table 5.

EDITORIAL COMMENT

On average, there were 108,700 infants born annually to military families and included in the Registry during 2003–2014. Active duty women contributed an average of approximately 14,600 infants annually to the Registry. Although the numbers of such infants were lowest in 2013 and 2014, the overall trend was relatively stable during the surveillance period. Births to dependent spouses increased by an average of 3.5% annually from 2003–2011, then decreased by an average of 2.5% in 2012 and 2013 before leveling off in 2014.

The observed trends in maternal age of active duty women, and in all women in the Registry overall (data not shown), with progressively fewer births to younger mothers and more to older mothers, mirrored what has been reported previously for the DoD population and for the general U.S. population.^{4–6} Other characteristics of active duty mothers, such as race/ethnicity, service branch, and military rank, were also similar to previous reports.⁴

In this descriptive overview, rates of adverse infant outcomes across all Registry populations were comparable to or lower than those seen in the general U.S. population.^{5,7} This observation is likely due to the younger and healthier nature of U.S. service

FIGURE 3. Annual rate of any major birth defect, by infant sex, among infants born to active duty U.S. military women, Department of Defense Birth and Infant Health Registry, 2003–2014

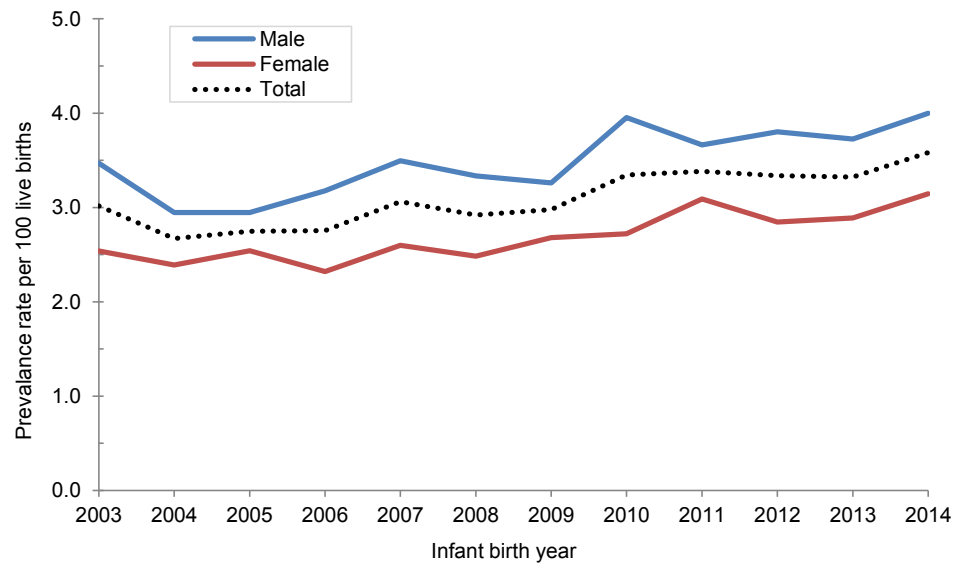
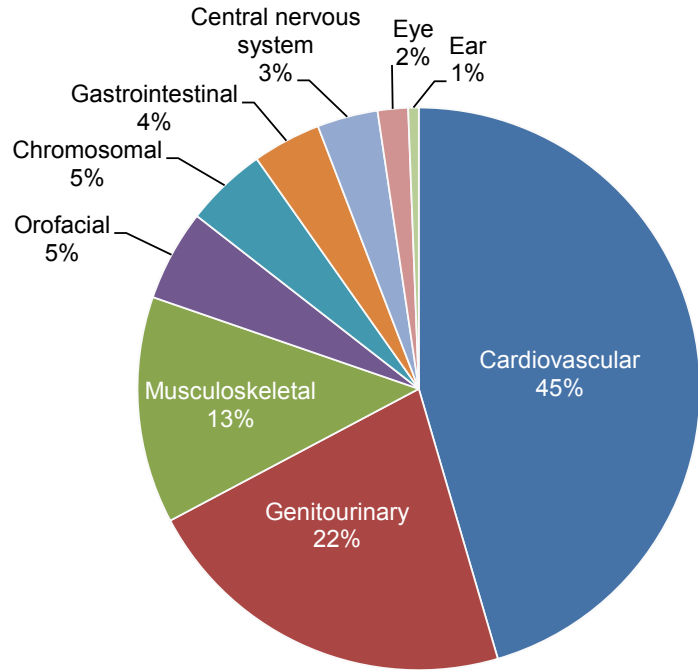


FIGURE 4. Distribution of birth defects, by organ system, among infants born to active duty U.S. military women, Department of Defense Birth and Infant Health Registry, 2003–2014



members and their dependents. Distributions by maternal age and race/ethnicity were also comparable: birth defect rates were highest for infants born to non-Hispanic white mothers/sponsors and women aged 35 years or older;⁷ preterm birth and LBW rates were higher among infants born

to non-Hispanic black mothers/sponsors as well as younger (less than 20 years) and older (35 years or older) mothers.^{7,8}

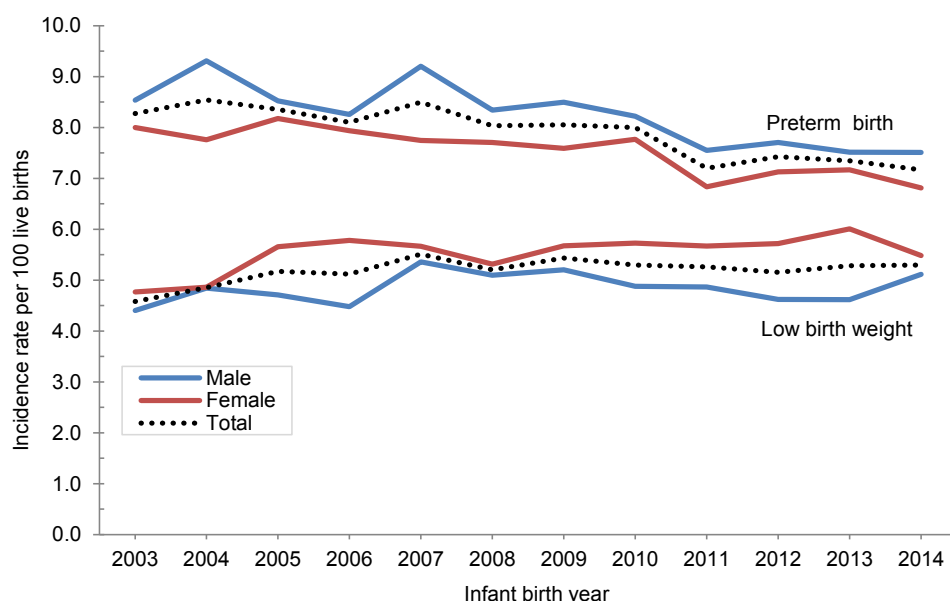
The birth defect rate among infants born to active duty women, and to Registry mothers overall, increased almost 20% between 2003 and 2014. This increase may

TABLE 3. Most prevalent birth defects among infants, Department of Defense Birth and Infant Health Registry, 2003–2014

Birth defect	Organ system	Rate per 10,000 live births
Infants born to active duty mothers		
Hypospadias ^a	Genitourinary	110.0
Atrial septal defect	Cardiovascular	87.2
Ventricular septal defect	Cardiovascular	66.7
Clubfoot	Musculoskeletal	20.1
Pulmonary valve atresia/stenosis	Cardiovascular	17.7
Down syndrome	Chromosomal	11.3
Cloacal exstrophy	Genitourinary	10.7
Cleft palate without cleft lip	Orofacial	10.1
Coarctation of the aorta	Cardiovascular	9.2
Tetralogy of Fallot	Cardiovascular	7.6
Infants born to all Registry mothers		
Hypospadias ^a	Genitourinary	102.4
Atrial septal defect	Cardiovascular	91.8
Ventricular septal defect	Cardiovascular	68.4
Clubfoot	Musculoskeletal	21.2
Pulmonary valve atresia /stenosis	Cardiovascular	16.6
Down syndrome	Chromosomal	14.1
Cleft palate alone	Orofacial	11.4
Coarctation of the aorta	Cardiovascular	9.3
Cloacal exstrophy	Genitourinary	8.5
Cleft lip with cleft palate	Orofacial	8.0

^aRate among male infants only

FIGURE 5. Annual rates of preterm birth and low birth weight, by infant sex, among infants born to active duty U.S. military women, Department of Defense Birth and Infant Health Registry, 2003–2014



be explained, at least in part, by increased detection with improved diagnostic technology/testing over time. This phenomenon has been observed previously and described in other populations.^{9,10} However, it is possible that real increases in the prevalence of certain individual defects (e.g., gastroschisis) could also contribute to this trend.¹¹

Rates of preterm birth have declined between 2003 and 2014 among both infants born to active duty women and in the Registry population overall. This decline has also been reported for the general U.S. population and attributed to a decreased proportion of births among younger mothers.⁸ It has also been suggested that increased awareness of risks associated with late preterm delivery have led to increased efforts to reduce non-medically indicated deliveries before completion of 39 weeks of gestation.⁵ Notably, an increase in preterm births has been observed in the general population between 2014 and 2015. Future investigations will determine whether this trend is apparent in the Registry population.⁵ The rates of LBW peaked in 2007 among infants born to active duty women and in 2008 in the Registry population overall, and declined slightly thereafter. A similar trend has been observed in the general U.S. population.⁵

On average, there were 21,500 pregnancies among active duty women each year between 2003 and 2014. Seventy percent of pregnancies resulted in a live birth, while 0.3% and 16% resulted in a stillbirth or other pregnancy loss, respectively. These Registry pregnancy outcome rates are generally comparable to previous reports for the military beneficiary population,¹² as well as to the general U.S. population,^{13,14} with the exception of a lower stillbirth rate. The lower rate of stillbirths is likely due to the Registry's conservative case definition.

Building on the descriptive findings in this report, analyses of Registry data have assessed a number of specific exposures of concern and found reassuring results based on the lack of associations with adverse reproductive outcomes. These studies include assessments of inadvertent exposure to smallpox vaccine,^{15–17} and/or anthrax vaccine,^{18,19} as well as influenza A/H1N1²⁰ vaccination in pregnancy among

FIGURE 6. Number of annual live births, in total and at military treatment facilities (MTFs), by maternal beneficiary type, Department of Defense Birth and Infant Health Registry, 2003–2014

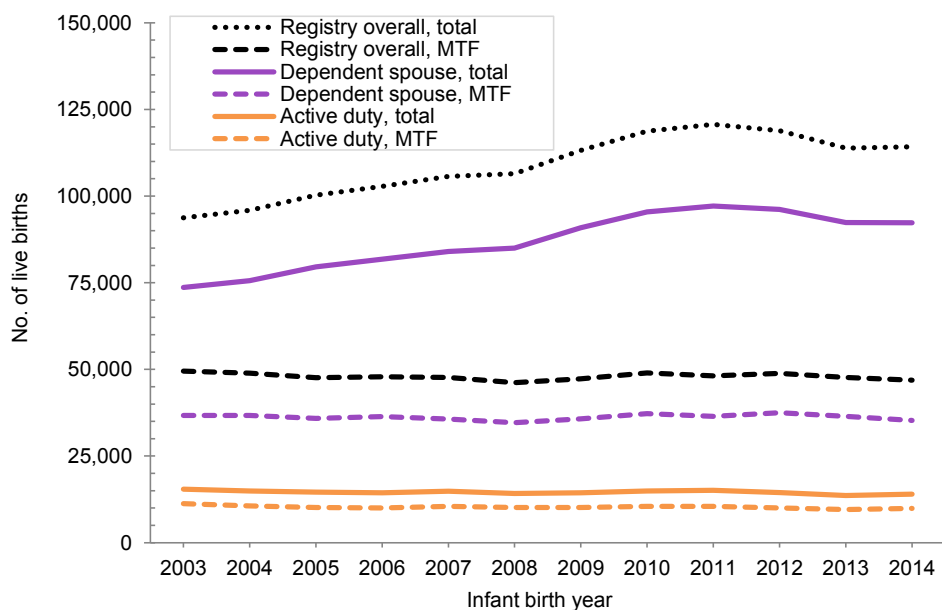
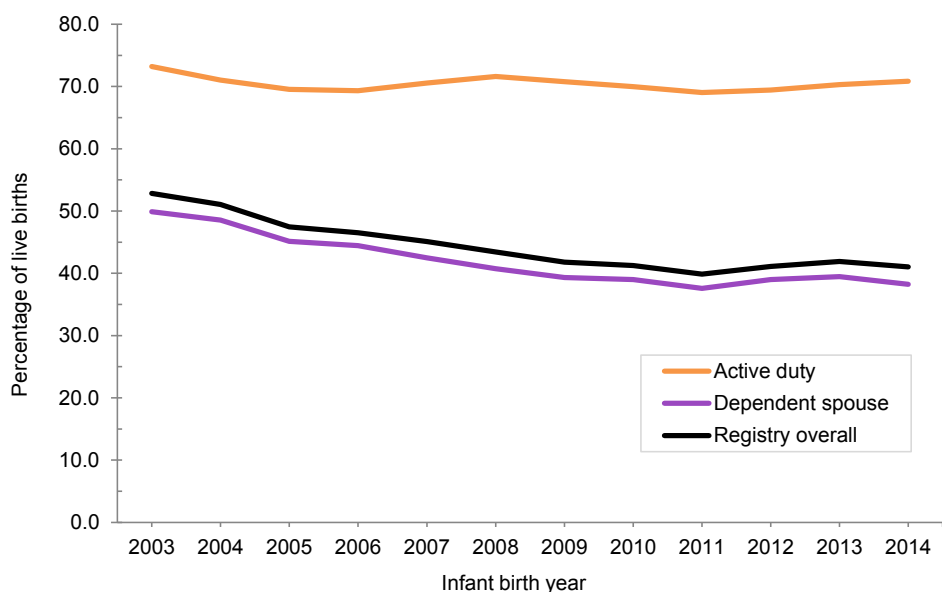


FIGURE 7. Annual percentages of infants born at military treatment facilities, by maternal beneficiary type, Department of Defense Birth and Infant Health Registry, 2003–2014



military women and their possible associations with adverse reproductive health outcomes, including infertility, pregnancy loss, preeclampsia, preterm labor and birth, as well as birth defects. Analyses of Registry data have also assessed risks for birth defects and preterm birth among infants of active duty women and men who were

deployed within 3 miles of an open-air burn pit before the start of their infant's gestation, or additionally during pregnancy for women,²¹ risks for adverse infant health outcomes among infants born to women who were inadvertently deployed to military operations during pregnancy,²² and long-term risks for birth defects among

infants born to service men and women deployed to the 1990–1991 Gulf War.²³

Registry data have also been used to assess a variety of outcomes outside of reproductive health. One study evaluated rates of and risk factors for abusive head trauma among infants born to military families.²⁴ Another assessed the relationship between timing of spousal deployment relative to pregnancy and postpartum depression among wives of U.S. military service members.²⁵ More recently, a study was performed to assess and identify predictors of suboptimal postpartum fitness and weight outcomes among active duty Navy women,²⁶ which led to policy changes in the Navy Physical Readiness Program.²⁷

The aforementioned studies are just a sample of the Registry's diverse research portfolio, which also includes the National Smallpox Vaccine in Pregnancy Registry and the BioThrax[®] (Anthrax) Vaccine in Pregnancy Registry. Both demonstrate the Registry's unique capabilities to answer a wide range of questions relating to maternal and infant health, including those of specific military relevance and broader interest. The Registry is currently expanding to include all pregnancies, including those not ending in live deliveries, among dependent spouses of military service members. This effort will enhance capabilities for assessing pregnancy exposures and outcomes, especially those that are less common. Another recent enhancement of the Registry is the capability to follow infants through early childhood and to assess pediatric outcomes beyond the first year of life, such as childhood cancers and developmental disorders.

As reflected by the wide variety of studies using Registry data, reproductive health is a broad discipline that covers topics from infertility, through maternal and pregnancy outcomes, to infant and child health. Registry analyses focus primarily on outcomes following exposures of potential concern. As such, evaluating maternal, pregnancy, and infant outcomes among female service members and their infants is essential because the possible effects of such exposures would likely be heightened in this group. Furthermore, with increasing numbers of women serving in the military, particularly those of childbearing age, and their broadening occupational roles,

TABLE 4. Outcomes among infants born to dependent spouses and in the Department of Defense Birth and Infant Health Registry overall, 2003–2014

Characteristic	Dependent spouses (N=1,043,812)				Registry overall (N=1,304,406)			
	M:F infant sex ratio	Any birth defect %	Preterm birth %	Low birth weight %	M:F infant sex ratio	Any birth defect %	Preterm birth %	Low birth weight %
Overall	1.06	3.2	9.0	4.3	1.06	3.1	9.0	4.5
Maternal age at infant birth (years)								
<20	1.06	3.0	9.4	5.2	1.06	2.7	9.6	5.2
20–24	1.06	3.0	8.6	4.3	1.06	3.0	8.6	4.4
25–29	1.06	3.1	8.4	3.9	1.06	3.1	8.4	4.1
30–34	1.05	3.2	9.1	4.3	1.05	3.2	9.2	4.4
35–39	1.05	3.8	11.3	5.3	1.05	3.8	11.3	5.4
≥40	1.07	4.8	14.0	7.2	1.07	4.8	14.2	7.5
Unknown	-	-	-	-	1.09	3.1	9.4	5.4
Sponsor marital status								
Married	1.06	3.2	9.0	4.3	1.06	3.1	9.0	4.4
Not married	1.06	3.1	9.5	5.0	1.06	3.1	9.5	5.5
Sponsor race/ethnicity								
Non-Hispanic white	1.06	3.3	8.8	4.0	1.06	3.2	8.7	4.0
Non-Hispanic black	1.04	3.0	11.0	6.4	1.04	3.0	11.2	6.8
Hispanic	1.05	2.9	8.5	4.3	1.05	2.9	8.4	4.4
Asian/Pacific Islander	1.07	2.7	8.5	4.8	1.07	2.7	8.6	4.8
American Indian/Alaska Native	1.02	3.0	8.8	4.1	1.03	2.9	8.7	4.1
Other/unknown	1.07	3.2	9.1	4.7	1.06	2.9	9.1	4.8
Sponsor education								
Less than bachelor's degree	1.06	3.1	9.1	4.5	1.06	3.1	9.1	4.6
Bachelor's degree or greater	1.05	3.3	8.7	3.9	1.06	3.3	8.9	4.1
Sponsor branch of service								
Army	1.05	3.2	9.2	4.5	1.06	3.1	9.3	4.7
Air Force	1.05	3.2	8.4	3.8	1.06	3.2	8.4	4.0
Navy	1.06	3.2	9.4	4.5	1.06	3.1	9.4	4.7
Marine Corps	1.06	3.0	8.8	4.3	1.06	2.9	8.7	4.3
Sponsor rank								
Enlisted	1.06	3.2	9.2	4.5	1.06	3.1	9.2	4.6
Officer	1.06	3.2	8.1	3.5	1.06	3.2	8.3	3.7
Unknown	1.57	11.1	11.1	11.1	1.46	6.8	6.8	3.4
Sponsor occupation								
Combat specialist	1.06	3.1	8.6	4.0	1.06	3.1	8.7	4.1
Healthcare specialist	1.06	3.1	9.0	4.4	1.06	3.1	9.0	4.6
Other/unknown	1.06	3.2	9.1	4.4	1.06	3.1	9.1	4.6
Infant birth year								
2003	1.04	2.9	9.1	4.1	1.04	2.9	9.1	4.2
2004	1.06	2.9	9.6	4.3	1.05	2.8	9.6	4.4
2005	1.05	3.0	9.4	4.3	1.05	2.9	9.5	4.5
2006	1.06	3.1	9.5	4.3	1.06	3.0	9.5	4.5
2007	1.05	3.1	9.4	4.4	1.05	3.0	9.5	4.6
2008	1.06	3.1	9.4	4.5	1.06	3.1	9.4	4.6
2009	1.06	3.1	9.2	4.4	1.06	3.1	9.2	4.6
2010	1.06	3.2	9.0	4.3	1.05	3.2	9.0	4.5
2011	1.06	3.3	8.8	4.4	1.06	3.3	8.8	4.5
2012	1.05	3.3	8.5	4.4	1.06	3.3	8.5	4.5
2013	1.07	3.5	8.2	4.3	1.07	3.4	8.3	4.5
2014	1.06	3.3	8.0	4.3	1.06	3.4	8.1	4.4
Infant sex								
Male	-	3.6	9.4	4.1	-	3.5	9.4	4.3
Female	-	2.7	8.6	4.6	-	2.7	8.6	4.7
Infant plurality								
Singleton	1.06	3.1	7.9	3.8	1.06	3.1	8.0	4.0
Multiple	-	4.5	91.3	42.2	-	4.4	91.3	43.1

M, male; F, female

TABLE 5. Pregnancies and outcomes among active duty U.S. military women, 2003–2014

Characteristics	All pregnancies		Live deliveries		Stillbirths		Other losses ^a		Unknown outcomes	
	No.	%	No.	%	No.	%	No.	%	No.	%
Overall	258,332		180,044 ^b	69.7	768	0.30	41,278	16.0	36,242	14.0
Maternal age at pregnancy end (years)										
<20	7,935	3.1	5,405	3.0	27	3.5	1,256	3.0	1,247	3.4
20–24	110,817	42.9	78,608	43.7	348	45.3	16,208	39.3	15,653	43.2
25–29	75,898	29.4	54,013	30.0	214	27.9	11,593	28.1	10,078	27.8
30–34	40,210	15.6	28,406	15.8	114	14.8	6,658	16.1	5,032	13.9
35–39	18,418	7.1	11,547	6.4	55	7.2	3,960	9.6	2,856	7.9
≥40	5,054	2.0	2,065	1.1	10	1.3	1,603	3.9	1,376	3.8
Mean (SD)	26.3	(5.3)	26.0	(5.0)	25.9	(5.3)	27.0	(5.9)	26.5	(5.9)
Median (IQR)	25	(22–29)	25	(22–29)	25	(22–29)	26	(22–31)	25	(22–30)
Maternal marital status										
Married	177,436	68.7	131,347	73.0	487	63.4	25,893	62.7	19,709	54.4
Not married	80,896	31.3	48,697	27.0	281	36.6	15,385	37.3	16,533	45.6
Maternal race/ethnicity										
Non-Hispanic white	121,727	47.1	86,711	48.2	276	35.9	19,107	46.3	15,633	43.1
Non-Hispanic black	74,169	28.7	49,118	27.3	339	44.1	12,206	29.6	12,506	34.5
Hispanic	34,683	13.4	24,406	13.6	76	9.9	5,664	13.7	4,537	12.5
Asian/Pacific Islander	15,520	6.0	11,123	6.2	43	5.6	2,310	5.6	2,044	5.6
American Indian/Alaska Native	5,832	2.3	4,193	2.3	12	1.6	890	2.2	737	2.0
Other/unknown	6,401	2.5	4,493	2.5	22	2.9	1,101	2.7	785	2.2
Maternal education										
Less than bachelor's degree	214,324	83.0	148,688	82.6	661	86.1	34,023	82.4	30,952	85.4
Bachelor's degree or greater	44,008	17.0	31,356	17.4	107	13.9	7,255	17.6	5,290	14.6
Maternal branch of service										
Army	93,489	36.2	60,415	33.6	280	36.5	16,439	39.8	16,355	45.1
Air Force	74,843	29.0	53,997	30.0	227	29.6	11,666	28.3	8,953	24.7
Navy	65,838	25.5	47,891	26.6	203	26.4	9,686	23.5	8,058	22.2
Marine Corps	18,663	7.2	13,761	7.6	46	6.0	2,682	6.5	2,174	6.0
Other/unknown	5,499	2.1	3,980	2.2	12	1.6	805	2.0	702	1.9
Maternal rank										
Enlisted	224,245	86.8	155,426	86.3	696	90.6	35,786	86.7	32,337	89.2
Officer	34,087	13.2	24,618	13.7	72	9.4	5,492	13.3	3,905	10.8
Maternal occupation										
Combat specialist	16,648	6.4	11,647	6.5	44	5.7	2,536	6.1	2,421	6.7
Healthcare specialist	47,916	18.5	34,120	19.0	124	16.1	7,773	18.8	5,899	16.3
Other/unknown	193,768	75.0	134,277	74.6	600	78.1	30,969	75.0	27,922	77.0
Pregnancy end year										
2003	24,746	9.6	16,101	8.9	88	11.5	3,426	8.3	5,131	14.2
2004	22,869	8.9	15,511	8.6	76	9.9	3,262	7.9	4,020	11.1
2005	21,234	8.2	14,888	8.3	76	9.9	2,891	7.0	3,379	9.3
2006	21,251	8.2	14,796	8.2	81	10.5	3,276	7.9	3,098	8.5
2007	21,881	8.5	15,303	8.5	68	8.9	3,578	8.7	2,932	8.1
2008	21,176	8.2	14,555	8.1	56	7.3	3,662	8.9	2,903	8.0
2009	21,357	8.3	14,815	8.2	56	7.3	3,710	9.0	2,776	7.7
2010	21,859	8.5	15,352	8.5	63	8.2	3,784	9.2	2,660	7.3
2011	21,723	8.4	15,566	8.6	52	6.8	3,494	8.5	2,611	7.2
2012	20,897	8.1	14,885	8.3	47	6.1	3,482	8.4	2,483	6.9
2013	19,536	7.6	14,054	7.8	54	7.0	3,313	8.0	2,115	5.8
2014	19,803	7.7	14,218	7.9	51	6.6	3,400	8.2	2,134	5.9

SD, standard deviation; IQR, interquartile range

^aPregnancies with indication of elective abortion were excluded from reporting.^bNot all live deliveries are included in the Registry's infant population due to standard exclusions.

leveraging Registry data to evaluate reproductive outcomes within this population will provide the military community with necessary information to identify successes and areas for potential improvement in prevention and care.

Inquiries and collaboration requests may be directed to the DoD Birth and Infant Health Registry either by phone (619-553-9255) or email (DOD.NHRC-BirthRegistry@mail.mil).

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Department of Defense Birth and Infant Health Registry



Increasing the understanding of how military service affects service members' reproductive health

Health Surveillance

- ✓ Maternal and pregnancy outcomes (including losses)
- ✓ Infant outcomes (including birth defects)

100K



Births annually to DoD beneficiaries

Service members and dependents

13%



Infants born to Active Duty mothers

Approximately 14,600 per year

1.8M

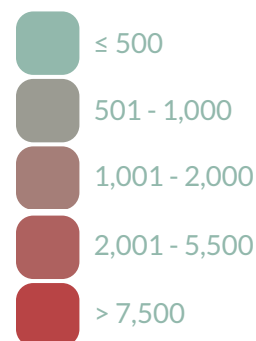
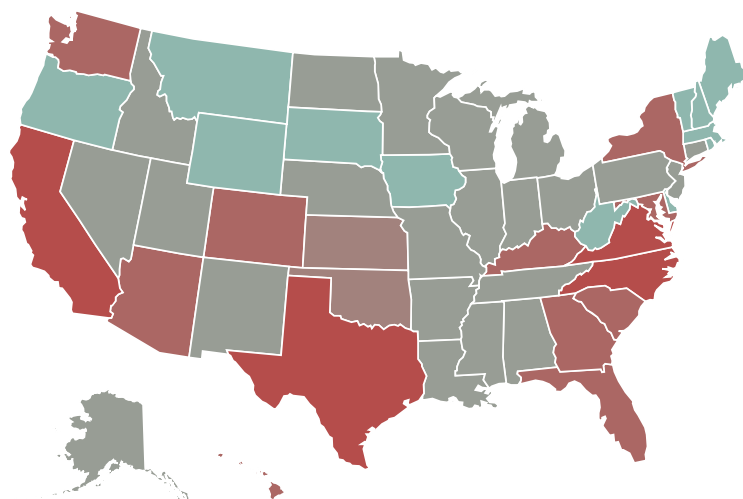


Infants in the Registry

Followed through first year of life

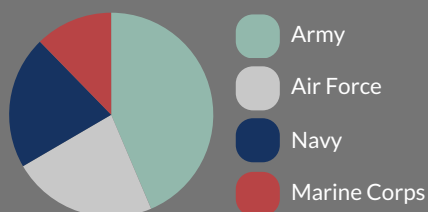
Average number of annual births

2003 - 2014



~5,800 overseas

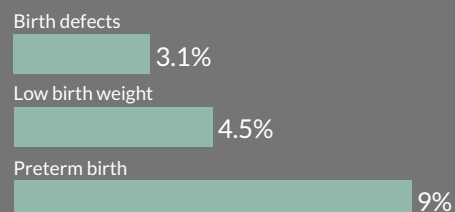
Births by service branch



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Infant outcome rates*



*Rates are comparable to non-military populations

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